

(12) **United States Patent**
Dighde et al.

(10) **Patent No.:** **US 9,195,083 B2**
(45) **Date of Patent:** **Nov. 24, 2015**

(54) **IMPACT RESISTANT CONSTRUCTION OF AN INTERACTIVE DEVICE**

(75) Inventors: **Rajesh Dighde**, Redmond, WA (US);
Andrew Hill, Redmond, WA (US)

(73) Assignee: **Microsoft Technology Licensing, LLC**,
Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

6,608,664 B1	8/2003	Hasegawa	
7,130,185 B2	10/2006	Chen et al.	
7,701,699 B2 *	4/2010	Ma	349/58
7,944,520 B2	5/2011	Ichioaka et al.	
2003/0128307 A1 *	7/2003	Ito et al.	349/58
2003/0202146 A1 *	10/2003	Takeda et al.	349/129
2003/0223024 A1	12/2003	Ogawa	
2005/0094039 A1 *	5/2005	Kim et al.	349/12
2007/0263347 A1 *	11/2007	Hong et al.	349/58
2008/0043171 A1	2/2008	Takahashi et al.	
2008/0074577 A1	3/2008	Sato	
2008/0297679 A1	12/2008	Jung et al.	

(Continued)

(21) Appl. No.: **13/284,989**

(22) Filed: **Oct. 31, 2011**

(65) **Prior Publication Data**

US 2013/0107143 A1 May 2, 2013

(51) **Int. Cl.**
G02F 1/1333 (2006.01)

(52) **U.S. Cl.**
CPC **G02F 1/133308** (2013.01); **G02F 1/13338**
(2013.01); **G02F 2001/133325** (2013.01); **G02F**
2001/133331 (2013.01); **G02F 2201/503**
(2013.01); **Y10T 29/49826** (2015.01)

(58) **Field of Classification Search**
CPC **G02F 2201/503**; **G02F 1/133308**;
G02F 2001/133325
USPC 349/56, 58, 60
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,150,231 A	9/1992	Iwamoto et al.	
5,568,357 A *	10/1996	Kochis et al.	349/58
5,606,438 A *	2/1997	Margalit et al.	349/60
5,846,942 A	12/1998	Horwell et al.	
6,175,396 B1	1/2001	Kim et al.	

FOREIGN PATENT DOCUMENTS

EP 2282255 A1 2/2011

OTHER PUBLICATIONS

Cheng, et al., "Design and Analysis of Shock-Absorbing Structure for Flat Panel Display", Retrieved at <<<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4383010>>>, IEEE Transactions on Advanced Packaging, vol. 31, No. 1, Feb. 2008, pp. 135-142.

(Continued)

Primary Examiner — Richard Kim

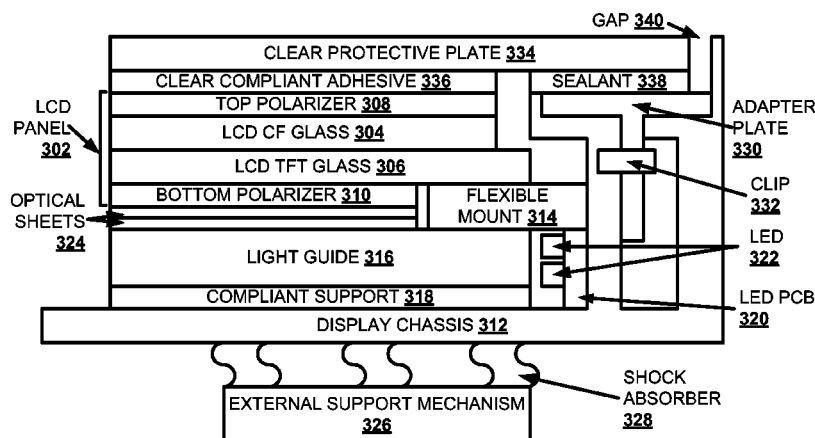
Assistant Examiner — Ryan Crockett

(74) Attorney, Agent, or Firm — Jeremy Snodgrass; Judy Yee; Micky Minhas

(57) **ABSTRACT**

In one embodiment, a high impact resistance display module 300 may avoid damage better than a standard display module 200. An interactive touch screen may create a mounting surface on a display chassis 312 that is level with a liquid crystal display panel 302 using an adjustable adapter plate 330. An interactive touch screen may attach an optically clear protective plate 334 to the liquid crystal display panel 302. An interactive touch screen may attach an optically clear protective plate 334 to the mounting surface.

20 Claims, 5 Drawing Sheets



300

(56)

References Cited

U.S. PATENT DOCUMENTS

2010/0045889	A1 *	2/2010	Yuan et al.	349/58
2010/0066936	A1 *	3/2010	Garrett et al.	349/58
2010/0103640	A1	4/2010	Brown et al.	
2010/0188623	A1 *	7/2010	Nakagawa	349/96
2010/0247940	A1	9/2010	Takahashi et al.	
2010/0296027	A1	11/2010	Matsuhira et al.	
2010/0321606	A1 *	12/2010	Liou et al.	349/60

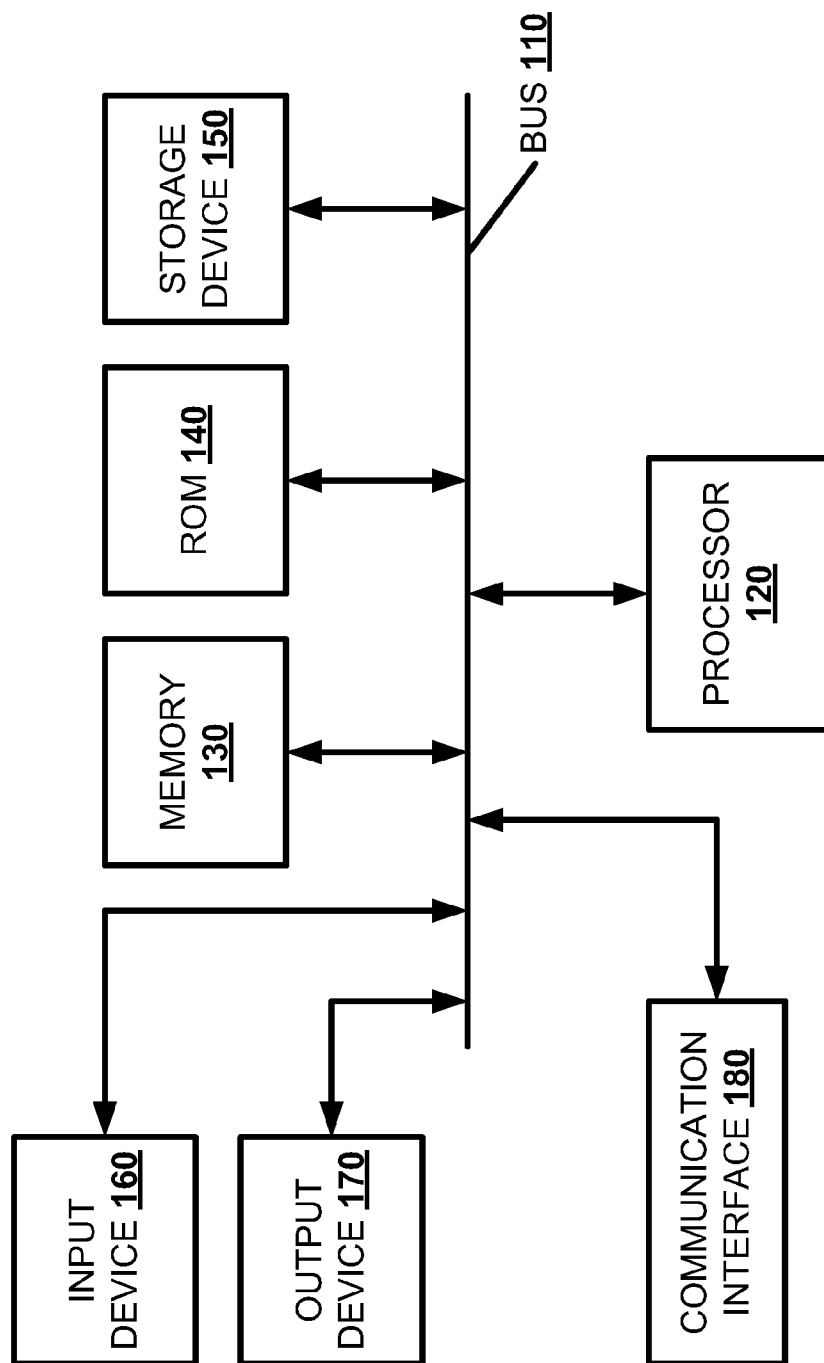
OTHER PUBLICATIONS

Dighde, et al., "Ruggedized Display Device", 12889212, Filed Date: Sep. 23, 2010, pp. 24.

"International Search Report", Mail Date: Mar. 25, 2013, Application No. PCT/US2012/062501, Filed date: Oct. 30, 2012, pp. 10.

"Extended European Search Report", Mail Date: Aug. 27, 2015, Application No. PCT/US2012/062501, pp. 9.

* cited by examiner



100
Figure 1

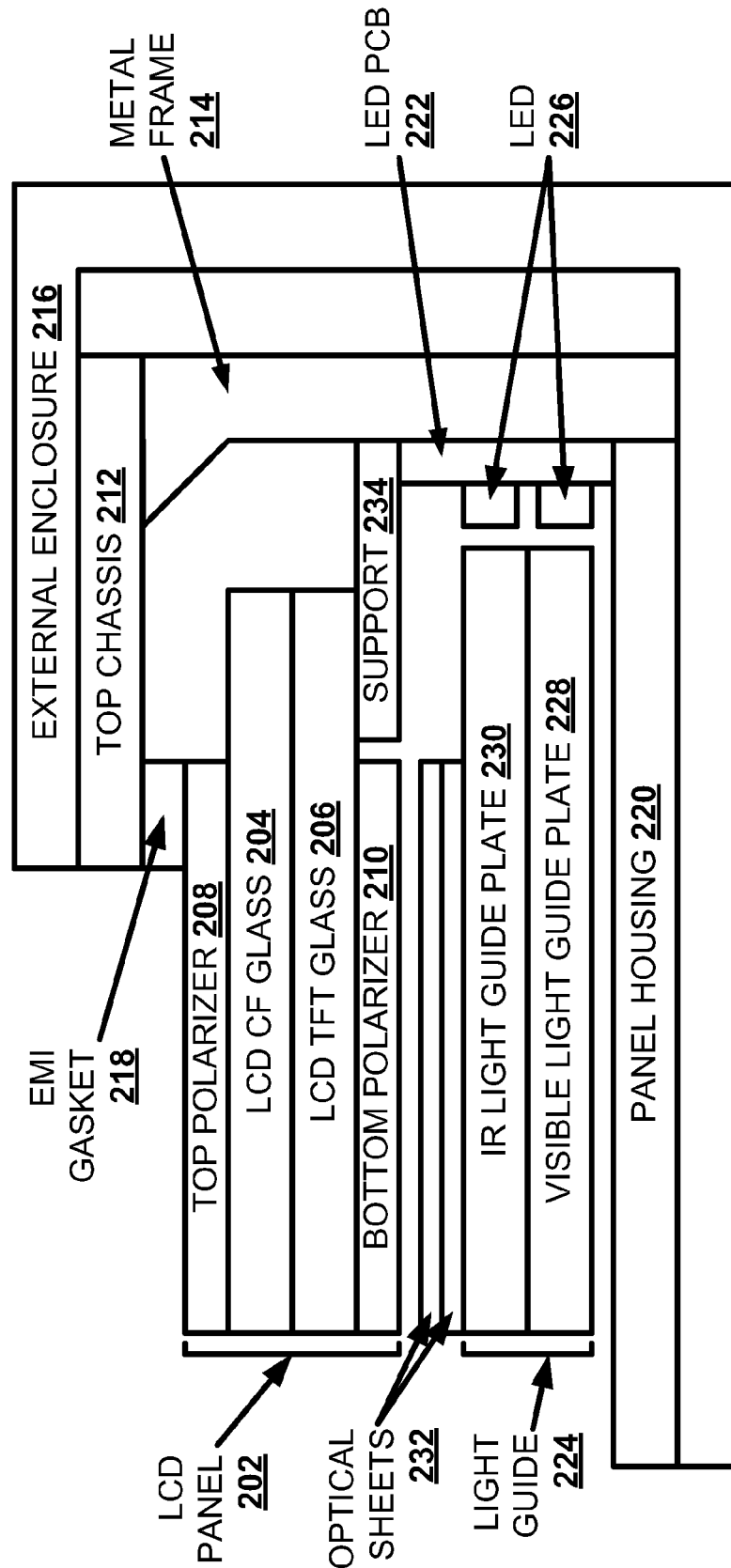
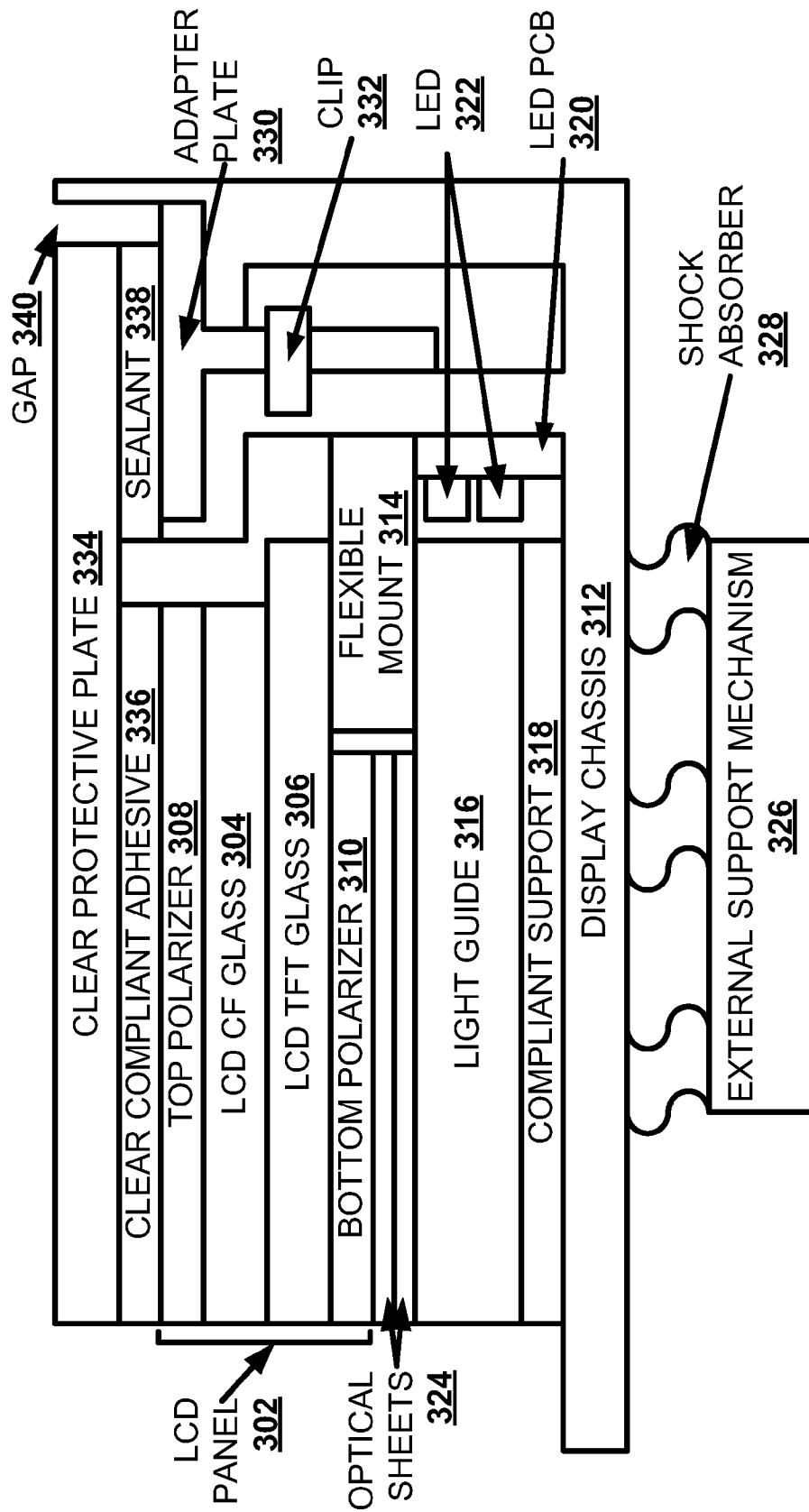
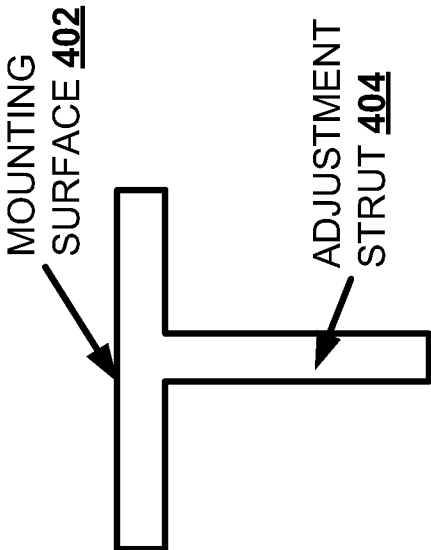


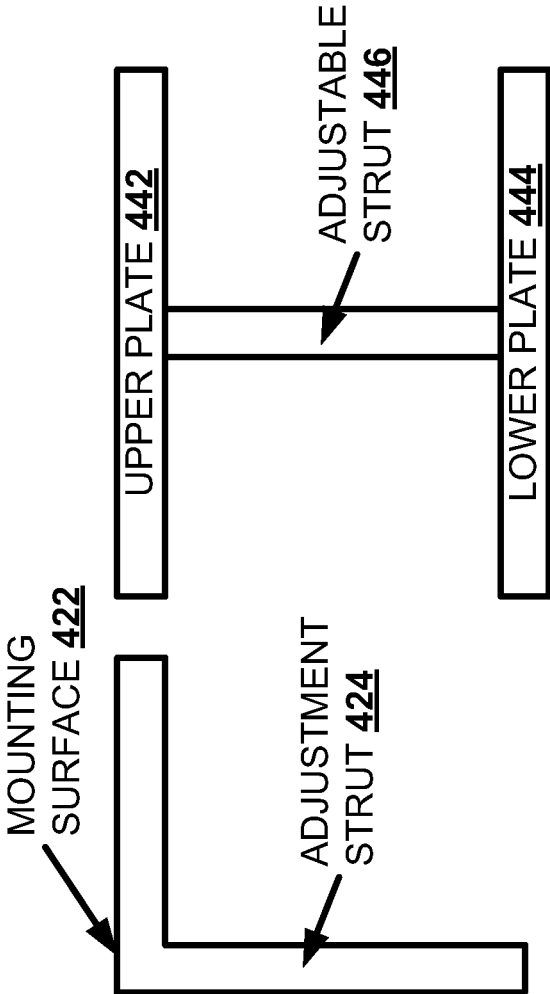
Figure 2



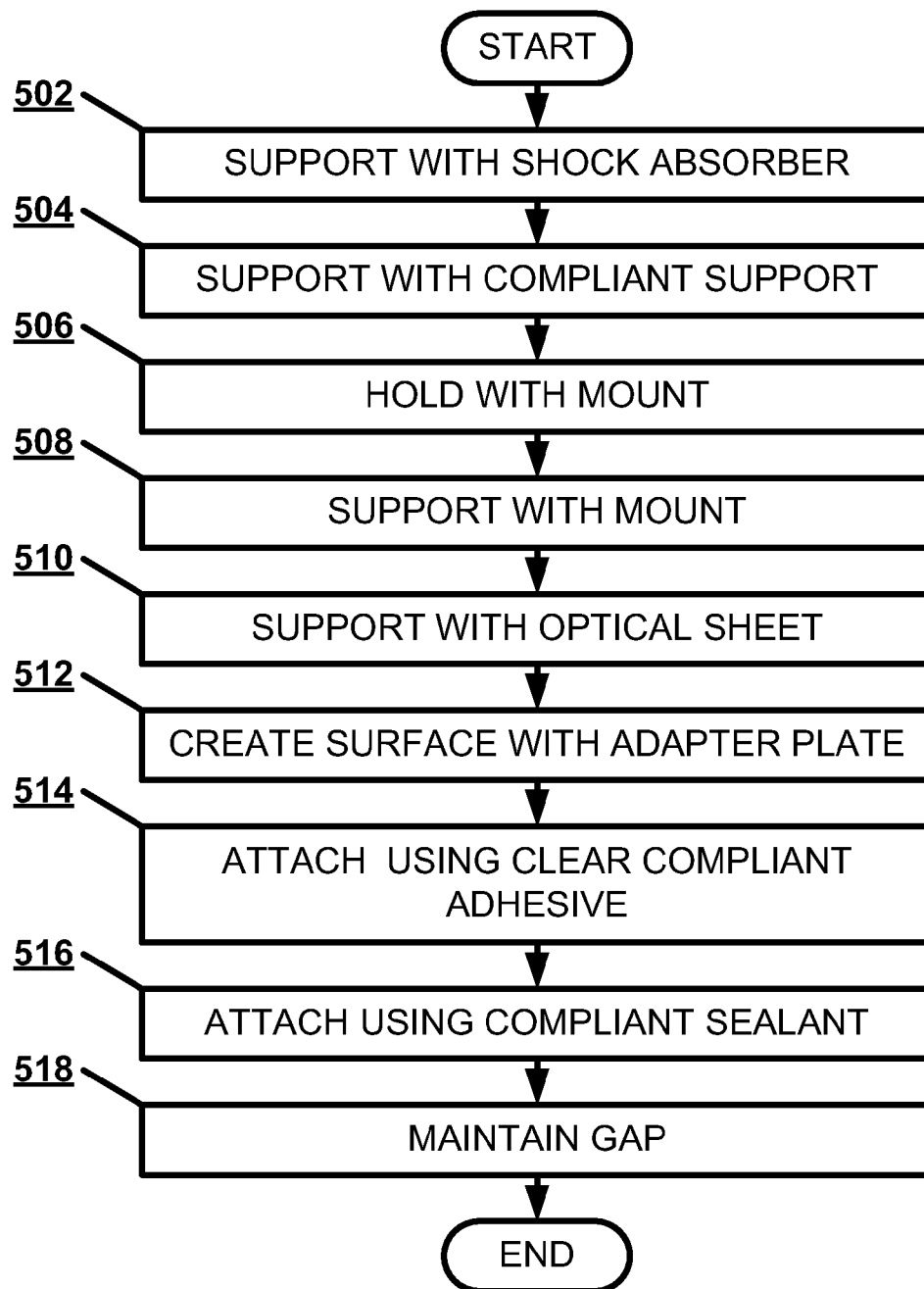
300
Figure 3



⁴⁰⁰
Figure 4a



⁴⁴⁰
Figure 4c



500
Figure 5

IMPACT RESISTANT CONSTRUCTION OF AN INTERACTIVE DEVICE

BACKGROUND

A large interactive multi-touch display may allow multiple users to interact with a device. To allow for greater interaction, the multi-touch display may have a seamless interactive area with the interactive cover glass extended to the edge. The interactive cover glass may be flush with a protective bezel surrounding the display. The seams between the interactive cover glass may be as small as possible to reduce the amount of contamination that may enter the seam.

SUMMARY

This Summary is provided to introduce a selection of concepts in a simplified form that is further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

Embodiments discussed below relate to avoiding damage to an interactive touch screen. An interactive touch screen may create a mounting surface on a display chassis that is level with a liquid crystal display panel using an adjustable adapter plate. An interactive touch screen may attach an optically clear protective plate to the liquid crystal display panel. An interactive touch screen may attach an optically clear protective plate to the mounting surface.

DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features can be obtained, a more particular description is set forth and will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments and are not therefore to be considered to be limiting of its scope, implementations will be described and explained with additional specificity and detail through the use of the accompanying drawings.

FIG. 1 illustrates, in a block diagram, one embodiment of a computing device having an interactive touch screen.

FIG. 2 illustrates, in a block diagram, one embodiment of a standard interactive display module.

FIG. 3 illustrates, in a block diagram, one embodiment of a high impact resistance display system.

FIGS. 4a-c illustrate, in block diagrams, different embodiments of adjustable adapter plates.

FIG. 5 illustrates, in a flowchart, one embodiment of a method for protecting a display system.

DETAILED DESCRIPTION

Embodiments are discussed in detail below. While specific implementations are discussed, it should be understood that this is done for illustration purposes only. A person skilled in the relevant art will recognize that other components and configurations may be used without parting from the spirit and scope of the subject matter of this disclosure. The implementations may be a machine-implemented method, an electronic device, or an interactive touch screen for a computing device.

Improvements to an interactive touch screen may improve response to an object drop related break or a side impact

related break of a display or the cover glass. A newer liquid crystal display, such as an organic light emitting diode (OLED), may be sensitive to applied or residual stress as the stress changes the polarization mode of the embedded liquid crystals and cause display defects, such as light leakage or different color bands. These defects may have a significant impact on the user experience. Changes may be made to the interactive touch screen structure to isolate the liquid crystal display panel from outside stresses. The interactive touch screen may have strategically placed compliant adhesives and structures to protect critical aspects of the interactive touch screen. A compliant adhesive or structure is any adhesive or structure that has a degree of give or flexibility that protects the adhesive or structures from impacts and other stresses.

Thus, in one embodiment, a high impact resistance display module may avoid damage better than a standard display module. An interactive touch screen may create a mounting surface on a display chassis that is level with a liquid crystal display panel using an adjustable adapter plate. An interactive touch screen may attach an optically clear protective plate to the liquid crystal display panel. An interactive touch screen may attach an optically clear protective plate to the mounting surface.

FIG. 1 illustrates a block diagram of an exemplary computing device **100** which may have an interactive touch screen. The computing device **100** may combine one or more of hardware, software, firmware, and system-on-a-chip technology to implement the electronic features of the impact resistant interactive touch screen. The computing device **100** may include a bus **110**, a processor **120**, a memory **130**, a read only memory (ROM) **140**, a storage device **150**, an input device **160**, an output device **170**, and a communication interface **180**. The bus **110** may permit communication among the components of the computing device **100**.

The processor **120** may include at least one conventional processor or microprocessor that interprets and executes a set of instructions. The memory **130** may be a random access memory (RAM) or another type of dynamic storage device that stores information and instructions for execution by the processor **120**. The ROM **140** may include a conventional ROM device or another type of static storage device that stores static information and instructions for the processor **120**. The storage device **150** may include any type of tangible machine-readable medium, such as, for example, magnetic or optical recording media and its corresponding drive.

The input device **160** may include one or more conventional mechanisms that permit a user to input information to the computing device **100**, such as an interactive touch screen, a keyboard, a mouse, a voice recognition device, a microphone, a headset, etc. The output device **170** may include one or more conventional mechanisms that output information to the user, including an interactive touch screen, a display, a printer, one or more speakers, a headset, or a medium, such as a memory, or a magnetic or optical disk and a corresponding disk drive. The communication interface **180** may include any transceiver-like mechanism that enables processing device **100** to communicate with other devices or networks.

The computing device **100** may have a standard display panel structure. FIG. 2 illustrates, in a block diagram, one embodiment of a standard interactive display module **200**. The standard interactive display module **200** may have a liquid crystal display (LCD) panel **202** for presenting the data to be projected through the screen. The liquid crystal display panel **202** may have a color filter (CF) glass **204** to determine color and a thin filter transistor (TFT) glass **206** to improve contrast. The color filter glass **204** may have a width between 0.3 mm and 0.7 mm. The thin filter transistor glass **206** may

have a width between 0.3 mm and 0.7 mm. The liquid crystal display panel **202** may have a top polarizer **208** and a bottom polarizer **210** to define the polarization of light entering and exiting the liquid crystal display panel **202**.

A top chassis **212** supported by a metal frame **214** may rest atop the outer edge of the liquid crystal display panel **202**. The top chassis may have a width of 0.6 mm. An external enclosure **216** may cover the top chassis **212** and metal frame **214**. An electromagnetic interference (EMI) gasket **218** may connect the top chassis **212** and the liquid crystal display panel **202** and prevent any outside contaminants from getting into the standard interactive display module **200**.

A panel housing **220** may support a light emitting diode (LED) printed circuit board (PCB) **222** and a light guide **224**. The light emitting diode printed circuit board **222** may have one or more light emitting diodes **226** directed into the light guide **224**. The light guide **224** may have a visible light guide plate **228** and an infrared (IR) light guide plate **230**. The light guide **224** may direct light from the light emitting diode **226** up through one or more optical sheets **232** to the liquid crystal display panel **202**.

A support **234** may project out from the metal frame **214** to support the liquid crystal display panel **202** above the light guide **224**. The support **234** may maintain a 2 mm air gap between the optical sheets **232** and the liquid crystal display panel **202**.

This standard interactive display module **200** may be modified to improve resistance to impact and side shocks. FIG. 3 illustrates, in a block diagram, one embodiment of a high impact resistance display module **300**. The high impact resistance display module **300** may have a liquid crystal display panel **302** for presenting the data to be projected through the screen. The liquid crystal display panel **302** may have a color filter glass **304** to determine color and a thin filter transistor glass **306** to improve contrast. The color filter glass **304** may have a width between 0.3 mm and 0.7 mm. The thin filter transistor glass **306** may have a width between 0.3 mm and 0.7 mm. The liquid crystal display panel **302** may have a top polarizer **308** and a bottom polarizer **310** to define the polarization of light entering and exiting the liquid crystal display panel **302**.

A display chassis **312** may contain the liquid crystal display panel **302**. A flexible mount **314** may project out from the display chassis **312** to support the liquid crystal display panel **302**. The display chassis **312** may support a light guide **316** with an optically clear compliant support **318**. The optically clear compliant support **318** may dissipate impact energy. The optically clear compliant support **318** may be placed in any place in the stack.

The display chassis **312** may support a light emitting diode printed circuit board **320**. The light emitting diode printed circuit board **320** may have one or more light emitting diodes **322** directed into the light guide **316**. The light guide **316** may direct light from the light emitting diode **322** up through one or more compliant optical sheets **324** to the liquid crystal display panel **302**. The compliant optical sheets **324** may dissipate impact energy and reduce stress on liquid crystals. The liquid crystal display panel **302** may be placed so that no gap exists between the liquid crystal display **302** and the compliant optical sheets **324**. The display chassis **312** may be placed on an external support mechanism **326** with one or more shock absorbers **328** connecting the display chassis **312** to the external support mechanism **326**. The shock absorbers **328** may dissipate vertical and side impacts.

An adjustable adapter plate **330** may be attached to the display chassis **312** with a clip **332** or other fastening mechanism. The adjustable adapter plate **330** may create a mounting surface that is level with the liquid crystal display panel **302**.

An optically clear protective plate **334** may be placed atop the liquid crystal display panel **302**. The optically clear protective plate **334** may be a chemically strengthened protective glass or plastic. The optically clear protective plate **334** may have a thickness of anywhere from 0.1 mm to 2 mm or more. An optically clear compliant adhesive **336** may attach the optically clear protective plate **334** to the liquid crystal display panel **302**. A compliant adhesive sealant **338** may attach the optically clear protective plate **334** to the adjustable adapter plate **330**. The compliant adhesive sealant **338** may be optically clear, translucent, or even opaque. The same optically clear compliant adhesive **336** may be used to cover the liquid crystal display panel **302** and the adjustable adapter plate **330** depending on the assembly sequence of the device. The adjustable adapter plate **330** may protect the edge of the optically clear protective plate **334** from side impact. The optically clear protective plate **334** may be placed to maintain a gasket or an air gap **340** to allow for a coefficient of thermal expansion mismatch between the display chassis **312** and the optically clear protective plate **334**. Thus, the optically clear protective plate **334** may expand at a different rate due to heat changes than the display chassis **312** without damaging either component.

A variety of adjustable adapter plates **330** may create the mounting surface on the display chassis **312**. As shown in FIG. 4a, the adjustable adapter plate **330** may be a T-bracket **400**. The level of the mounting surface **402** of the T-bracket **400** may be moved to be level with the liquid crystal display panel by positioning an adjustment strut **404** in a gap in the display chassis **312**.

As shown in FIG. 4b, the adjustable adapter plate **330** may be an L-bracket **420**. The level of the mounting surface **422** of the L-bracket **420** may be moved to be level with the liquid crystal display panel by positioning an adjustment strut **424** in a gap in the display chassis **312**. The L-bracket **420** may form a rectangular liquid crystal display chassis to house electronics, light emitting diodes, optical sheets, and a light guide plate. This assembly scheme may be used to provide a face down assembly of the interactive device by using the liquid crystal display on a flat surface. This arrangement may enable an interactive device with a flat top surface with the optical sheets and the light guide plate providing support from beneath.

As shown in FIG. 4c, the adjustable adapter plate **330** may be an H-bracket **440**. The H-bracket **440** may have an upper plate **442** and a lower plate **444**. An adjustable strut **446** may vary the distance between the upper plate **442** and the lower plate **444**. The lower plate **444** may be placed on the display chassis **312** while the upper plate **442** acts as a mounting surface for the optically clear protective plate **334**.

FIG. 5 illustrates, in a flowchart, one embodiment of a method **500** for protecting a display system. One or more shock absorbers **328** may support a display chassis **312** above the external support mechanism **326** (Block **502**). An optically clear compliant support **318** may support a light guide **316** on the display chassis **312** (Block **504**). A flexible mount **314** may hold the light guide **316** to the display chassis **312** (Block **506**). The flexible mount **314** may support a liquid crystal display panel **302** (Block **508**). A compliant optical sheet **324** may support the liquid crystal display panel **302** while dissipating impact energy (Block **510**). An adjustable adapter plate **330** may create a mounting surface on the display chassis **312** that is level with the liquid crystal display panel **302** (Block **512**). The adjustable adapter plate **330** may be a T-bracket **400**, an L-bracket **420**, or an H-bracket **440**. An optically clear compliant adhesive **336** may attach the opti-

5

cally clear protective plate 334 to the liquid crystal display panel 302 (Block 514). A compliant adhesive sealant 338 may attach the optically clear protective plate 334 to the mounting surface of the adjustable adapter plate 330 (Block 516). The optically clear protective plate 334 may maintain an expansion gap 340 with a display chassis 312 rim to allow for thermal expansion (Block 518).

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms for implementing the claims.

Although the above description may contain specific details, they should not be construed as limiting the claims in any way. Other configurations of the described embodiments are part of the scope of the disclosure. For example, the principles of the disclosure may be applied to each individual user where each user may individually deploy such a system. This enables each user to utilize the benefits of the disclosure even if any one of a large number of possible applications do not use the functionality described herein. Multiple instances of electronic devices each may process the content in various possible ways. Implementations are not necessarily in one system used by all end users. Accordingly, the appended claims and their legal equivalents should only define the invention, rather than any specific examples given.

We claim:

1. A method, comprising:

creating a mounting surface on a display chassis that is level with a polarizer of a display panel using an adjustable adapter plate movable relative to a level of the display panel by positioning an adjustment strut of the adjustable adapter plate relative to the display chassis; attaching an optically clear protective plate to the display panel; and attaching the optically clear protective plate to the mounting surface.

2. The method of claim 1, further comprising:

supporting the display panel with a compliant optical sheet that dissipates impact energy.

3. The method of claim 1, further comprising:

supporting the display panel with a flexible mount.

4. The method of claim 1, further comprising:

holding a light guide with a flexible mount.

5. The method of claim 1, further comprising:

supporting a light guide with an optically clear compliant support.

6. The method of claim 1, further comprising:

attaching the optically clear protective plate to the display panel with an optically clear compliant adhesive.

7. The method of claim 1, further comprising:

attaching the optically clear protective plate to the adjustable adapter plate with a compliant adhesive sealant.

8. The method of claim 1, further comprising:

supporting the display chassis with a shock absorber.

6

9. The method of claim 1, further comprising:

maintaining an expansion gap between the optically clear protective plate and a display chassis rim to allow for thermal expansion.

10. The method of claim 1, further comprising:

using at least one of a T-bracket, an L-bracket, and an H-bracket as the adjustable adapter plate.

11. An electronic device comprising:

a display panel;

a display chassis that contains the display panel;

an optically clear protective plate disposed over the display panel;

an adjustable adapter plate movable relative to a level of the display panel to create a mounting surface level with a polarizer of the display panel for attaching the optically clear protective plate by positioning an adjustment strut of the adjustable adapter plate relative to the display chassis; and

a compliant optical sheet that supports the display panel and dissipates impact energy.

12. The electronic device of claim 11, further comprising: a light guide beneath the compliant optical sheet.

13. The electronic device of claim 12, further comprising: an optically clear compliant support that supports the light guide.

14. The electronic device of claim 12, further comprising: a flexible mount to hold the light guide and support the display panel.

15. The electronic device of claim 11, wherein the optically clear protective plate maintains an expansion gap with a display chassis rim to allow for thermal expansion.

16. The electronic device of claim 11, further comprising: an optically clear compliant adhesive attaching the optically clear protective plate to the display panel.

17. The electronic device of claim 11, wherein the adjustable adapter plate is at least one of a T-bracket, an L-bracket, and an H-bracket.

18. The electronic device of claim 11, further comprising: a compliant adhesive sealant attaching the adjustable adapter plate to the optically clear protective plate.

19. An interactive touch screen, comprising:

a display panel;

a display chassis that contains the display panel;

an optically clear protective plate disposed over the display panel;

an adjustable adapter plate movable relative to a level of the display panel to create a mounting surface level with a polarizer of the display panel for attaching the optically clear protective plate by positioning an adjustment strut of the adjustable adapter plate relative to the display chassis;

a compliant optical sheet that supports the display panel and dissipates impact energy; and

a shock absorber attached to an external support mechanism to support the display chassis.

20. The interactive touch screen of claim 19, further comprising:

a light guide beneath the compliant optical sheet; and an optically clear compliant support that supports the light guide.

* * * * *